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**BUTTERFLY VALVE METHOD AND APPARATUS.**

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## Description

### TECHNICAL FIELD

This invention relates generally to butterfly valve methods and apparatus, and more specifically to those which employ or incorporate structure that permits translational movement of the valve plate relative to the pivot mechanism.

### BACKGROUND OF THE INVENTION

U.S. Patent 3,498,583 Friedell discloses a compound movement butterfly valve in which the valve plate is moved perpendicularly thereto in order to effect seating and unseating. The features of the first part of both independent claims 1 and 3 are disclosed in U.S. Patent 3,498,583.

In butterfly valves, translational movement of the valve plate relative to the pivot mechanism can be used to effect dynamic torque balancing, and to facilitate actuation by using the torque exerted by fluid on the plate to rotate the latter. To applicants' knowledge, these principles were first set forth in the US patent application serial number 374,897, filed on June 30, 1989 which is one of the claimed priorities. They are schematically illustrated in FIGS. 12A-12C of the present application, wherein numerals 20, 22, 24, 26, and 28 indicate a valve plate, a pivot shaft, a duct, a bracket intersecuring the shaft and plate, and the direction of flow respectively. Arrow 30 and numeral 32 indicate the center of pressure associated with the forces exerted by fluid on the plate 20, and the pivot line about which the plate is rotatable.

In FIG. 12A, the shaft 22 is centered in relation to the longitudinal dimension of the plate 20 and the plate is in a closed position. The center of pressure 30 is aligned with the pivot line 32, so the net torque exerted by the fluid on the plate 20 is zero. If the plate 20 is rotated to an open position as illustrated in FIG. 12B, and translated relative to the shaft 22 so that the center of pressure 30 is aligned with the pivot line 32 as illustrated in FIG. 12C, then the plate is effectively torque-balanced and the flow rate associated with the rotational angle 34 can be maintained with minimal input force required from the actuator 36. If the translational movement is too limited in range to achieve torque balancing at all rotational positions of the plate 20, it can still be used to advantage in minimizing the net torque exerted by the fluid, thus still minimizing the input force required from the actuator 36.

If it is desired to change the rotational angle 34, then the plate 20 can be translated relative to the shaft 22 in the appropriate direction to effect a misalignment of the center of pressure 30 with the pivot line 32, thus increasing the net fluid dynamic torque, and the force required to effect the change is exerted in whole or in part by the fluid conveyed in the duct

24.

Butterfly valves that are designed to provide for translational movement of the plate 20 relative to the shaft 22, for either or both of the above-described purposes, are referred to herein as "balanced-torque" butterfly valves.

Upon reflection, it will be understood that the use of balanced-torque butterfly valves in applications which demand a rotational angle 34 corresponding to a closed position presents the problem of providing for translational movement while also providing for initial opening of the valve plate 20. Several arrangements have been proposed for initial opening of the plate 20. These include the following: 1) movably mounting the shaft 22 in the duct 24 so that the former is displaceable in a direction perpendicular to its own longitudinal axis, thus effecting a misalignment of the center of pressure 30 with the pivot line 32 at the zero angle; 2) providing a pilot valve through the plate, the pilot valve being actuated open at the zero angle in order to change the location of the center of pressure; and 3) mounting an actuator on the plate, the actuator having an output shaft revolvably secured to the pivot shaft 22, and using the actuator to effect both rotation for initial opening and translation for subsequent torque balancing.

The above-described arrangements require unconventional structures with unconventional actuation schemes. In many applications it may be desirable to provide for both initial opening and subsequent translation using an actuation scheme which is conventional in the sense that only a single externally-disposed actuator 36 is required to operate the valve. In addition, it is generally desirable to minimize the torque requirements of the actuator 36 so that a smaller actuator can be used.

### DISCLOSURE OF THE INVENTION

This invention provides a balanced-torque butterfly valve method and apparatus as defined by the features of claims 1 to 3. The term "balanced-torque" is meant to convey that the method employs a butterfly valve structure adapted to provide for translational movement of the valve plate relative to the pivot mechanism about which the valve plate is pivotal in the flow path; or, in the context of the apparatus, that the apparatus incorporates such structure. The advantages associated with such movement are described in the above BACKGROUND section.

A butterfly valve in accord with the invention comprises a spring or equivalent biasing mechanism which resists translational movement of the valve plate. In use of that arrangement, rotational movement of the pivot mechanism is converted to rotational or translational movement of the valve plate, depending on the relationship between the force exerted on the plate by the biasing mechanism and the net

torque exerted on the plate by the fluid.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an assembled butterfly valve. Actuation of the valve is represented.

FIG. 2 is an exploded perspective view of the butterfly valve illustrated in FIG. 1.

FIG. 3 is a partially elevational, partially cross-sectional, and partially exploded view of various components illustrated in FIG. 2, including a pivot mechanism and a differential gear.

FIGS. 4-6 are cross-sectional views taken along the lines indicated in FIG. 3.

FIG. 7 is an elevational and truncated view of the pivot mechanism.

FIG. 8 is a top elevation of the valve plate illustrated in FIGS. 1 and 2.

FIG. 9 is a side elevation, in partial cross-section, of the valve plate illustrated in FIG. 8.

FIG. 10 is a partial, cross-sectional and partially elevational view of the butterfly valve, as viewed in a direction parallel to both the valve plate and the pivot mechanism.

FIG. 11 is an elevational and partially fragmented view taken along lines 11-11 of FIG. 10.

FIGS. 12A-12H are schematic illustrations of a balanced-torque butterfly valve showing various rotational and translational positions of the valve plate. These are provided for dual purposes of illustrating the principles of a balanced-torque butterfly valve, and illustrating the method of the invention.

FIG. 13 is a schematic illustration wherein the butterfly valve incorporates a contemplated sealing arrangement in an application demanding a sealing function.

## BEST MODE FOR CARRYING OUT THE INVENTION

FIG. 1 of the accompanying drawings illustrates a butterfly valve 40 which is operable via an external actuator 36 to control the position of a valve plate 42. The valve plate 42 is pivotally disposed in and transmits a flow path 44 (FIG. 10) defined by a mounting body 46.

In use, duct members (not shown) are secured to the mounting body 46 to define an elongate flow path along which a fluid is conveyed from a source thereof, through the valve 40, and to one or more points of use. Fluid flow is controlled by rotationally positioning the valve plate 42. The positioning is achieved in response to torque applied by the actuator 36 to an input shaft 48. This torque is transmitted through a differential gear 50 (FIG. 3, hereinafter "differential") to a pivot mechanism 52 (FIG. 7) which pivotally supports the valve plate 42 and is journaled in the mounting body 46.

FIGS. 8 and 9 illustrate the valve plate 42 in more detail. The diameter of the circular valve plate 42 is slightly less than the inside diameter of the mounting body 46 in order to accommodate translational movement of the plate in the flow path 44. Translational movement of the valve plate 42 relative to the pivot mechanism 52 (FIG. 7) is accommodated by a suitably dimensioned cavity 54 extending through the plate as indicated. Slots 56, 58 are formed between the downstream-facing surface 60 of the plate and the cavity 54. Small tapped bores (not shown) extending into the plate receive screws 61 that secure an arcuate fence 62 to the plate near the leading edge of the latter. The slots 56, 58 are provided for securement of a pair of rack gears 64, 66 (FIG. 2) to the plate 42.

FIGS. 2, 3, and 7 illustrate the pivot mechanism 52 and differential 50 in detail. The pivot mechanism 52 comprises a center shaft 70 and a carrier shaft 72 (hereinafter, "carrier"). The carrier 72 has a centrally-disposed oblong portion 76 and two cylindrical end portions 78, 80. One end portion 78 is threaded for engagement with a nut 82, and the other end portion 80 has a transversely-extending bore 84 formed therethrough. A longitudinally-extending stepped bore 86 is formed in the carrier 72 to accommodate receipt of the center shaft 70 and to provide a housing for the differential 50. The bore 86 is sufficiently large in diameter to permit rotation of the center shaft 70 therein. Transverse slots 90, 92 are milled in the central portion 76, and through-slots 94, 96 are formed from the transverse slots to the upstream-facing surface 98 of the carrier. The through-slots 94, 96 intersect the longitudinally extending bore 86 as indicated. Five deep recesses (as at 100) and associated cross-slots (as at 102) are milled in the carrier 72 for installation of five rollers (as at 104). Each roller 104 is rotatably secured to a small shaft (as at 106) via needle bearings 107 (FIG. 6). The shaft 106 is force-fitted in the cross-slot 102. The rollers 104 function as bearings to minimize friction between the carrier 72 and the valve plate 42 during translational movement 109 (FIG. 10) of the latter. The longitudinally-extending bore 86 is enlarged at two locations and bearings 108, 110 are inserted. A bearing 88 is also pressed onto the cylindrical portion 80 as shown. A leaf spring 112 is rigidly secured to the edge of the carrier 72 via screws extending into tapped bores. (Note: Although the illustrated prototype incorporates the leaf spring 112, it is believed that a more robust biasing mechanism is preferable for most applications. Accordingly, the leaf spring 112 can be replaced by two suitably mounted and positioned coil springs, or such other functionally equivalent biasing means as are required in a given application).

A first bevel gear 114 of the differential 50 is pressed onto the center shaft 70 near the indicated end which extends into the differential housing. The

center shaft 70 is received in the longitudinally-extending bore 86 and extends through the bearings 108, 110, and through two pinion gears 116, 118 positioned in the through-slots 94, 96 as illustrated.

A cross-shaft 120 is pressed through the cross-bore 84 and through needle bearings (not shown) received in the axial bores (not shown) of second and third bevel gears 122, 124. The fourth bevel gear 126 of the differential 50 is pressed onto the input shaft 48. The input shaft 48 extends through a stepped axial bore in an end cap 74 and is pressed through bearings seated in the latter. The end cap 74 is then secured to the end of the carrier 72 as indicated, with the fourth bevel gear 126 engaging the second and third 122, 124, and the latter two engaging the first 114 to form the differential 50.

It will be understood that the first and fourth bevel gears 114, 126 are rigidly secured to the center shaft 70 and input shaft 48, respectively, whereas the second and third bevel gears 122, 124 are rotatably secured to the cross-shaft 120. When rotational torque is applied to the input shaft 48, it is transmitted through the differential 50 to the center shaft 70. If the center shaft 70 is free to rotate, then it will do so in response to rotation of the input shaft 48. However, if the center shaft 70 is constrained from rotating, then the torque is transmitted to the carrier 72 via the cross-shaft 120.

The rack gears 64, 66 are positioned in the transverse slots 90, 92 and in engagement with the pinion gears 116, 118. The valve plate 42 is held inside the mounting body 46 and the leaf spring 112 is depressed as the pivot mechanism 52 is extended through an access port 128 and the cavity 54 (FIG. 9) until the threaded end portion 78 projects through on opposite port 130 formed through the mounting body.

Two semi-annular baffles 132, 134 are positioned around the carrier 72 between the bearing 88 and the central portion 76, and against an annular rim or boss 138 of the mounting body 46. The inside-facing surfaces (those not visible in FIG. 2) of the baffles 132, 134 are contoured to conform with the inner surface 68 of the mounting body 46, and the surfaces are flush when the baffles are positioned as described.

The pivot mechanism 52 is further extended through the cavity 54 until the bearing 88 abuts an annular land 140 defined by the baffles 132, 134. A cover plate 142 abuts the opposite side of the bearing 88 and is secured to the mounting body 46 via screws (as at 144) extending through bores (as at 146) and into tapped bores (as at 148). The cover plate 142 circumferentially surrounds the end portion 80 and the latter, along with the input shaft 48, projects through a central bore 150 in the cover plate.

The rack gears 64, 66 are rigidly secured to the valve plate 42 via screws (as at 151) extending through the slots 56, 58 (FIG. 8) and into tapped

bores (as at 152) formed in the rack gears. A bearing 136 is pressed into the port 130 between the cylindrical portion 78 and the mounting body 46, and the pivot mechanism 52 is finally secured by tightly engaging the nut 82 with the threaded end portion 78.

When the valve 40 is assembled, the center shaft 70 is centered in relation to the valve plate 42 so that, in use, the net fluid dynamic torque is substantially zero when the plate is in the closed position. The leaf spring 112 is preloaded and abuts one transversely-extending, inside surface 154 (FIG. 9) of the valve plate 42, while the rollers 104 on the other end of the carrier 72 abut the opposite transversely-extending, inside surface 156. At all times, the rollers 104 collectively abut both oppositely-facing and longitudinally-extending inside surfaces (not referenced by numerals, these are the surfaces which are generally parallel to the valve plate as viewed in FIGS. 9 and 10) of the valve plate 42. Accordingly, the carrier 52 and rollers 104 cooperate to bear the pressure exerted by fluid on the valve plate so that load-bearing by the rack and pinion gears 64, 66, 116, 118 is limited to that associated with power transmission.

When the input shaft 48 is rotated, the rotational torque is transferred to the center shaft 70 and the normal response, in the absence of the leaf spring 112, is rotation of the center shaft 70. Rotation of the center shaft 70 is accompanied by translational movement 109 of the valve plate 42 relative to the carrier 72 via coaction of the rack and pinion gears 64, 66, 116, 118. If the translational movement is impeded sufficiently to prevent rotation of the center shaft 70, then the response to rotation of the input shaft 48 is rotation of the carrier 72 and, consequently, rotation of the valve plate 42. Since the oblong portion 76 of the carrier 72 is generally conformal with the cavity 54 (allowing, however, for translational movement and the provision of rollers 104), the valve plate 42 and carrier coact to rotate together when either is rotated; and since the cylindrical end portion 80 of the carrier extends outwardly from the flow path 44 and through the mounting body 46, the rotational position of the valve plate is easily ascertainable from the exterior of the mounting body by reference to the rotational position of the carrier.

Impedance of translational movement can occur without use of the leaf spring 112 when the valve plate 42 is in the closed position, since the plate is then forced edgewise against the inside surface 68 of the mounting body 46. However, such an arrangement requires considerably higher initial opening torque since the impedance is accompanied by frictional forces between the mounting body 46 and valve plate 42. Accordingly, the preferred embodiment incorporates a biasing mechanism so that rotational movement is the normal response when the valve plate 42 is moved from the closed position. In open rotational positions, the valve plate 42 moves rotationally in re-

sponse to rotation of the input shaft 48 so long as impedance to rotational movement--the impedance resulting from net fluid dynamic torque--is insufficient to overcome the impedance to translational movement that results from the spring force. When the impedance to rotational movement is sufficiently high, (i.e. when the center of pressure 30 is sufficiently misaligned with the pivot line 32 as illustrated in FIGS. 12, the pivot line of the preferred embodiment being the longitudinal axis of the carrier 72), then the valve plate 42 moves translationally to decrease the net torque until the impedance is again insufficient to overcome that resulting from the spring force.

In applications which demand sealing in the closed rotational position, a conventional rim seal can be provided around the circumferential periphery of the valve plate 42. This may limit translational movement too much, which in turn may require suitable shaping of the inside surface 68 of the mounting body 46 in order to accommodate the required movement. Alternatively, a suitably shaped inside surface 46 in combination with face seals may be workable. FIG. 13 illustrates a contemplated arrangement in which fluid communication is sealingly closed with the valve plate 42 at a rotational angle of approximately zero. The mounting body 46 is adapted to provide a suitable stop 158 in order to prevent undesired rotational movement of the valve plate 42. To accommodate translational movement, the inside surface 68 of the mounting body 46 is radially extended over a range 159 immediately downstream from an annular recess 160 formed in the circumferential edge of the valve plate 42. The recess 160 is offset from the carrier 72 to provide circumferentially continuous sealing. A seal 162 is seated in the recess 160 and abuts the inside surface 68. A potential difficulty in butterfly valves which employ rim seals in high-pressure-ratio applications is that the high-pressure fluid on the upstream side of the valve plate 42 gets between the recess 160 and the seal 162. The fluid exerts radially outward force on the seal 162, which puts the seal in more aggressive contact with the inside surface 68. While that effect may be desirable for sealing purposes, it has the undesirable consequence of increasing the torque required to initially open the valve. Accordingly, in the FIG. 13 arrangement the valve plate 42 is adapted to provide one-way fluid communication from the recess 160 to the downstream side of the plate in order to relieve the forementioned outward pressure exerted on the seal 162. This is accomplished by forming an inner annulus 164 which fluidically connects the recess 160 to a flow passage 166. The passage 166 extends from the annulus 164 to the downstream-facing surface of the valve plate 42, and is blocked by a check valve 168. A push rod 170 is rigidly secured to the carrier 72 and is in contact with the check valve 168 so that a very slight translational movement of the valve plate 42 results in opening the

check valve. In the closed position illustrated, the seal 162 impedes rotational movement of the valve plate 42 to a greater degree than the spring 112 (FIG. 2) impedes translational movement. Accordingly, when the valve plate 42 is sealingly closed as shown, rotation of the input shaft 48 (FIG. 2) results in rotation of the center shaft 70, and the valve plate is translated very slightly relative to the carrier 72. This slight translational movement opens the check valve 168, thus relieving the radially outward pressure exerted on the seal 162 and decreasing impedance to rotational movement of the valve plate 42. Use of the check valve 168 for both biasing (i.e. as an equivalent to the leaf spring 112 of FIG. 2) and seal-venting purposes is a possibility that has not been fully explored.

It should be understood that although a circular valve plate 42 is illustrated, the invention is equally applicable in a rectangular valve plate/rectangular duct arrangement, and that the term "butterfly valve" as used herein is intended to include such structures.

Referring now to FIGS. 12A-12F, it can be seen that in the method of the invention a valve plate 20 which is initially at a first rotational position (FIG. 12A) maximally closing fluid communication along the flow path 44, is rotationally moved away from the first position toward a second rotational position (FIG. 12F) maximally permitting fluid communication. The valve plate 20 is subjected to a net torque exerted by the fluid conveyed along the path 44 and the net torque increases with the rotational movement as the center of pressure 30 moves below the pivot line 32, this being illustrated in FIG. 12B. The valve plate 20 is translationally moved relative to the pivot shaft 22 so that the center of pressure 30 is more closely aligned with the pivot line 32, thus decreasing the net torque, as illustrated in FIG. 12C. Continued rotational movement toward the second position (FIG. 12F), facilitated by the translational movement, is effected with a concomitant increase in the net torque as the center of pressure 30 again moves relative to the pivot line 32, this being illustrated in FIG. 12D. Continued translational movement again more closely aligns the center of pressure 30 with the pivot line 32 so that further rotational movement toward the second position (FIG. 12F) is facilitated, as indicated in FIG. 12E.

Rotational movement of the valve plate 20 continues until the plate reaches a desired rotational position (as in FIG. 12E) associated with a desired flow rate. The translational movement facilitates the rotational movement and, since the net torque exerted by the fluid on the plate is minimized via the translational movement, minimizes the load on the actuator 36 at the desired rotational position.

The overall movement of the valve plate is characterized by both rotational and translational components, although it may be substantially continuous between one rotational position and another. Thus, the progression indicated by FIGS. 12A-12E exaggerates

the discreteness of successive translational or rotational components of movement, to the end of providing an easily understood illustration of the overall movement.

FIGS. 12G and 12H illustrate that the method of the invention can be practiced in reverse. That is, starting from a rotational position such as that illustrated in FIG. 12E where the valve plate 20 is substantially torque-balanced, the plate is rotationally moved toward the first position (FIG. 12A), thus effecting a greater degree of misalignment between the center of pressure 30 and the pivot line 32, as illustrated in FIG. 12G. The valve plate 20 is also translationally moved as illustrated in FIG. 12H to effect a lesser degree of misalignment, thus facilitating further rotational movement toward the first position.

The reader should understand that the foregoing portion of the description, which description includes the accompanying drawings, is not intended to restrict the scope of the invention to the preferred embodiment thereof or to specific details which are ancillary to the teaching contained herein. The invention should be construed in the broadest manner which is consistent with the following claims.

## Claims

1. A butterfly valve (40) comprising a body (46) defining a flow path therein for conducting a flow of fluid therethrough; a plate-like butterfly valve member (42) spanning said flow path for closing the latter in a first position of said valve member wherein the latter is generally perpendicular to said flow path, said valve member pivoting about an axis (32) traversing said flow path to a second position wherein said valve member spans said flow path and is generally parallel therewith to open the latter for flow of said fluid therein; operative input means (48) for effecting pivotal movement of said valve member between said first and said second positions;

characterized in that the valve further comprises kinematic means (70, 66, 118) for effecting translational movement (109) of said valve member in a direction generally parallel thereto and perpendicular to said pivot axis (32) in response to said operative input means (48); and

a yieldable resilient member (112) cooperating with said operative input means and said valve member to exert a biasing force inhibiting said translational movement, whereby said kinematic means is delayed in its operation so that said valve member pivots from said first position through an initial opening angle substantially without said translational movement, said resilient member being disposed to continue resisting

said translational movement beyond said initial opening angle so that said pivotal or translational movement is alternatively effected depending on whether torque exerted by said fluid on said valve member is sufficient to overcome said biasing force.

2. The butterfly valve of Claim 1 wherein said yieldable resilient member (112) includes an elongate leaf spring disposed generally parallel with said pivot axis (32) and effective between the latter and said valve member (42) to resist said translational movement (109).

3. A method of operating a butterfly valve (40) having a duct (24) wherein is conveyed a flow of fluid, a plate-like butterfly valve member (42) disposed in said duct and pivotal about a pivot axis (32) traversing said duct between a first closed position wherein said valve member spans and is generally perpendicular to said duct and a second open position wherein said valve member spans and is generally parallel with said duct; said method comprising the step of pivoting said valve member from said first position through an initial opening angle toward said second position;

characterized in that said method further comprises the steps of exerting a biasing force substantially inhibiting translational movement of said valve member (42) relative to said pivot axis (32) during pivoting of said valve member through said initial opening angle, and translationally moving said valve member after further pivotal movement past said initial opening angle and in response to said biasing force being overcome by torque exerted on said valve member by said fluid, wherein said translational movement is in directions generally parallel to said valve member and generally perpendicular to said pivot axis.

## Patentansprüche

1. Drehklappenventil (40) mit einem einen Strömungsweg zum Leiten einer Fluidströmung durch ihn hindurch begrenzenden Körper, welcher Strömungsweg von einem plattenartigen Drehklappenventilglied (42) zum Schließen desselben in einer ersten Lage des Ventilgliedes überbrückt ist, in welcher das letztere im wesentlichen senkrecht zum Strömungsweg liegt, welches Ventilglied um eine den Strömungsweg durchquerende Achse (32) in eine zweite Lage schwenkbar ist, in der das Ventilglied sich im Strömungsweg erstreckt und im wesentlichen parallel mit ihm ist, um den letzteren für eine Strömung von Fluid darin freizugeben, wobei zum Bewirken der Schwenkbewegung des Ventilgliedes zwischen

seiner ersten und zweiten Lage eine betriebliche Eingabeeinrichtung (48) vorgesehen ist;

dadurch gekennzeichnet, daß das Ventil ferner eine kinematische Einrichtung (70, 66, 118) zum Bewirken einer Verschiebebewegung (109) des Ventiltgliedes in einer im wesentlichen dazu parallelen und zur Schwenkachse (32) senkrechten Richtung in Abhängigkeit von der betrieblichen Eingabeeinrichtung (48) aufweist; sowie

ein nachgiebiges elastisches Glied (112), das mit der betrieblichen Eingabeeinrichtung und dem Ventiltglied zum Ausüben einer die Verschiebebewegung verhindernden Belastungskraft zusammenwirkt, wodurch die kinematische Einrichtung bei ihrem Betriebe derart verzögert wird, daß das Ventiltglied aus der ersten Lage im wesentlichen über einen Anfangsöffnungswinkel ohne die Verschiebebewegung schwenkt, wobei das elastische Glied so ausgebildet ist, daß es über den Anfangsöffnungswinkel hinaus weiterhin der Verschiebebewegung einen Widerstand entgegensetzt, so daß die Schwenk- oder die Verschiebebewegung wechselweise erfolgt, je nachdem, ob ein vom Fluid auf das Ventiltglied ausgeübtes Drehmoment ausreicht, um die Belastungskraft zu überwinden.

2. Drehklappenventil nach Anspruch 1, bei dem das nachgiebige elastische Glied (112) eine längliche Blattfeder aufweist, die im wesentlichen parallel zur Schwenkachse (32) angeordnet und zwischen der letzteren und dem Ventiltglied (42) wirksam ist, um sich der Verschiebebewegung zu widersetzen.

3. Verfahren zum Betreiben eines Drehklappenventiles (40) mit einer Leitung (24), in der eine Fluidströmung gefördert wird, einem in der Leitung angeordneten plattenartigen Drehklappenventiltglied (42), das um eine die Leitung durchquerende Schwenkachse (32) zwischen einer ersten, geschlossenen Lage schwenkbar ist, bei der das Ventiltglied die Leitung überspannt und im wesentlichen senkrecht zu ihr liegt, und einer zweiten, offenen Lage, bei der das Ventiltglied sich in der Leitung erstreckt und im wesentlichen parallel zu ihr liegt; welches Verfahren den Verfahrensschritt des Verschwenkens des Ventiltgliedes aus der ersten Lage über einen Anfangsöffnungswinkel gegen die zweite Lage umfaßt;

dadurch gekennzeichnet, daß das Verfahren ferner die Verfahrensschritte der Ausübung einer Belastungskraft aufweist, die im wesentlichen eine Verschiebebewegung des Ventiltgliedes (42) relativ zur Schwenkachse (32) während des Verschwenkens des Ventiltgliedes über den Anfangsöffnungswinkel verhindert, sowie der Ver-

schiebebewegung des Ventiltgliedes nach einer weiteren Schwenkbewegung nach dem Anfangsöffnungswinkel und in Abhängigkeit davon, daß die Belastungskraft durch ein durch das Fluid auf das Ventiltglied ausgeübtes Drehmoment überwunden wird, wobei die Verschiebebewegung in im wesentlichen parallel zum Ventiltglied und im wesentlichen senkrecht zur Schwenkachse verlaufenden Richtungen erfolgt.

## Revendications

1. Vanne papillon (40) comprenant un corps (46) définissant intérieurement un trajet d'écoulement pour acheminer un écoulement de fluide à travers lui ; un élément (42) de vanne papillon semblable à une plaque, recouvrant ledit trajet d'écoulement afin de fermer ce dernier dans une première position dudit élément de vanne dans laquelle ce dernier est généralement perpendiculaire audit trajet d'écoulement, ledit élément de vanne pivotant autour d'un axe (32) traversant ledit trajet d'écoulement jusqu'à une seconde position dans laquelle ledit élément de vanne recouvre ledit trajet d'écoulement et est généralement parallèle à celui-ci pour ouvrir ce dernier et permettre l'écoulement dudit fluide ; un moyen d'entrée opérationnel (48) pour effectuer un mouvement de pivotement dudit élément de vanne entre lesdites première et seconde positions ;

caractérisée en ce que la vanne comprend en outre un moyen cinématique (70, 66, 118) pour effectuer un mouvement de translation (109) dudit élément de vanne dans une direction généralement parallèle à celui-ci et perpendiculaire audit axe de pivotement (32) en réponse audit moyen d'entrée opérationnel (48); et

un élément élastique (112) coopérant avec ledit moyen d'entrée opérationnel et ledit élément de vanne pour exercer une force de sollicitation qui inhibe ledit mouvement de translation, d'où il résulte que ledit moyen cinématique est retardé dans son fonctionnement de sorte que ledit élément de vanne pivote à partir de ladite première position suivant un angle d'ouverture initiale sensiblement exempt dudit mouvement de translation, ledit élément élastique étant disposé pour continuer à résister audit mouvement de translation au-delà dudit angle d'ouverture initiale de sorte que ledit mouvement de pivotement ou de translation est effectué alternativement en fonction du fait que le couple exercé par ledit fluide sur ledit élément de vanne est suffisant pour vaincre ladite force de sollicitation.

2. Vanne papillon selon la revendication 1, dans laquelle ledit élément élastique (112) comprend un

ressort à lame allongé, disposé généralement parallèlement audit axe de pivotement (32) et permettant entre ce dernier et ledit élément de vanne (42) de résister audit mouvement de translation (109).

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3. Procédé pour faire fonctionner une vanne papillon (40) comprenant une conduite (24) dans laquelle un écoulement de fluide est acheminé, un élément (42) de vanne papillon en forme de plaque est disposé dans ladite conduite et peut pivoter autour d'un axe de pivotement (32) traversant ladite conduite entre une première position fermée dans laquelle ledit élément de vanne recouvre ladite conduite et est généralement perpendiculaire à celle-ci et une seconde position ouverte dans laquelle ledit élément de vanne recouvre ladite conduite et est généralement parallèle à celle-ci; ledit procédé comprenant l'étape consistant à faire pivoter l'élément de vanne à partir de ladite première position, par l'intermédiaire d'un angle d'ouverture initiale, vers ladite seconde position ; caractérisé en ce que ledit procédé comporte en outre les étapes consistant à exercer une force de sollicitation inhibant sensiblement le mouvement de translation dudit élément de vanne (42) par rapport audit axe de pivotement (32) pendant le pivotement dudit élément de vanne suivant ledit angle d'ouverture initial, et déplaçant par translation ledit élément de vanne après un nouveau mouvement de pivotement au droit dudit angle d'ouverture initiale et en réponse au fait que ladite force de sollicitation est surmontée par le couple exercé sur ledit élément de vanne par ledit fluide, où ledit mouvement de translation s'effectue dans une direction généralement parallèle audit élément de vanne et généralement perpendiculaire audit axe de pivotement.

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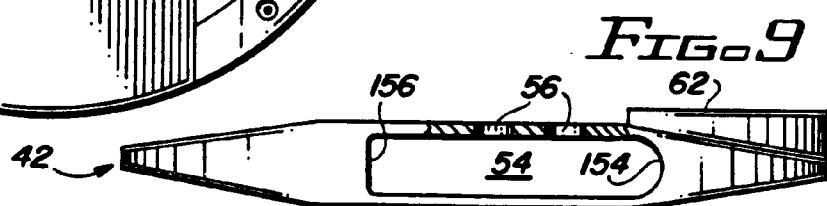
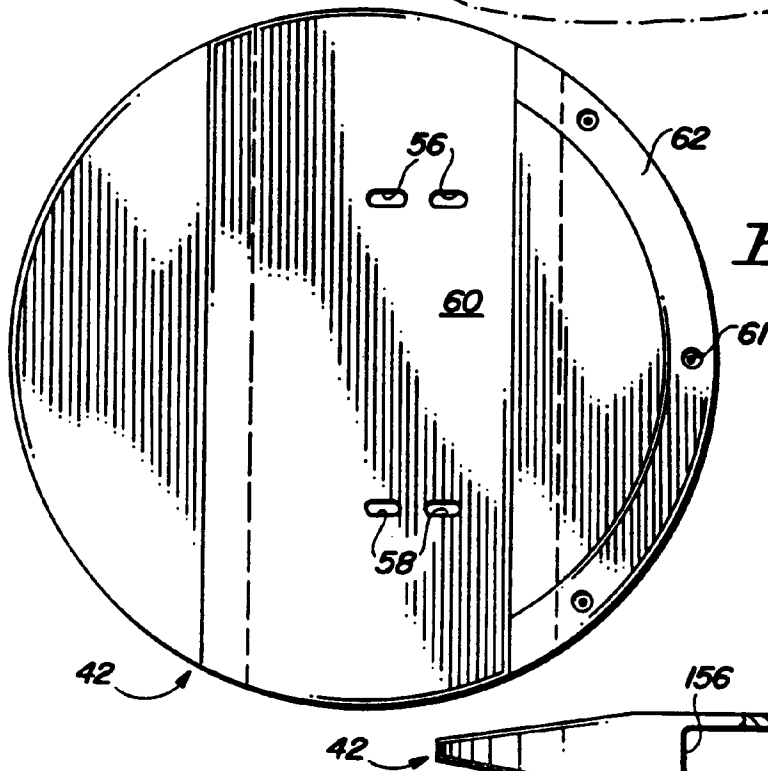
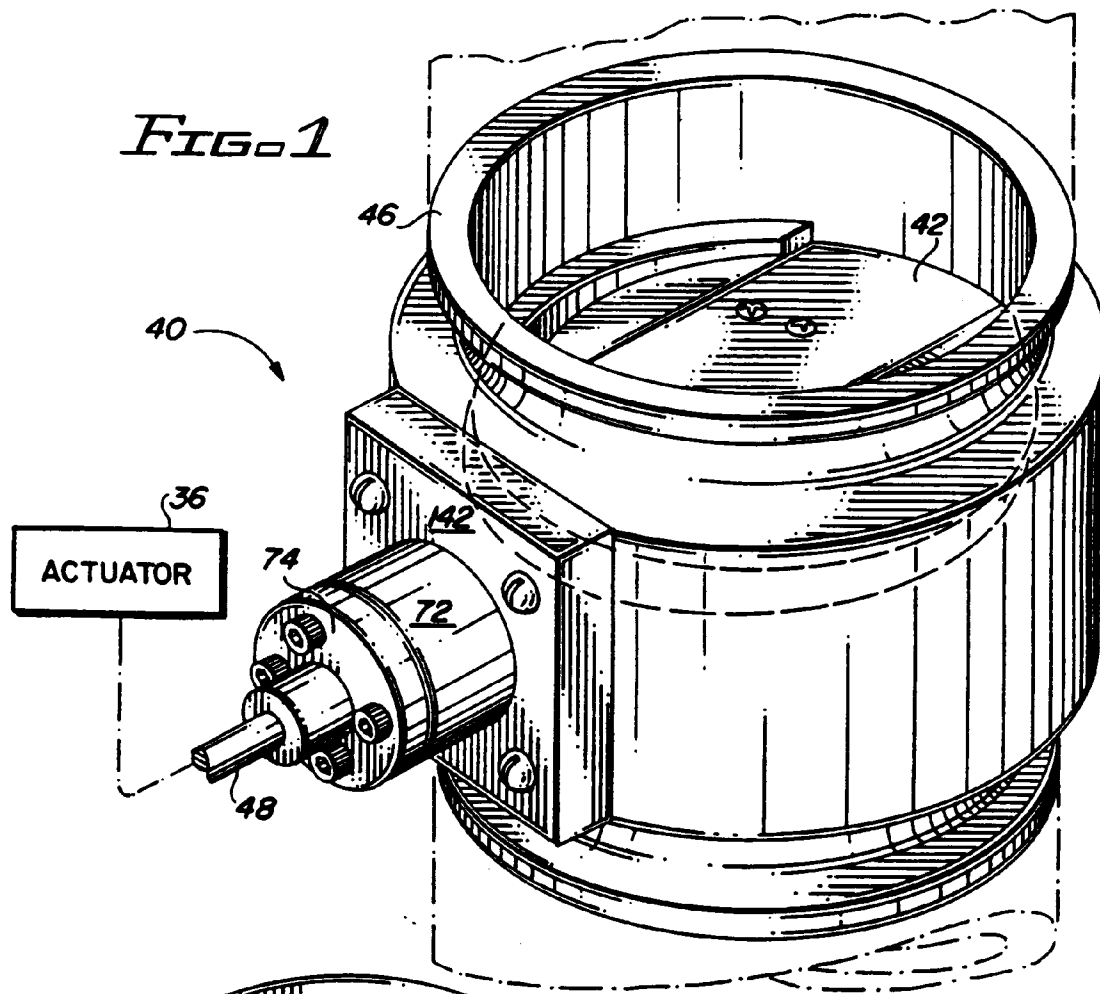
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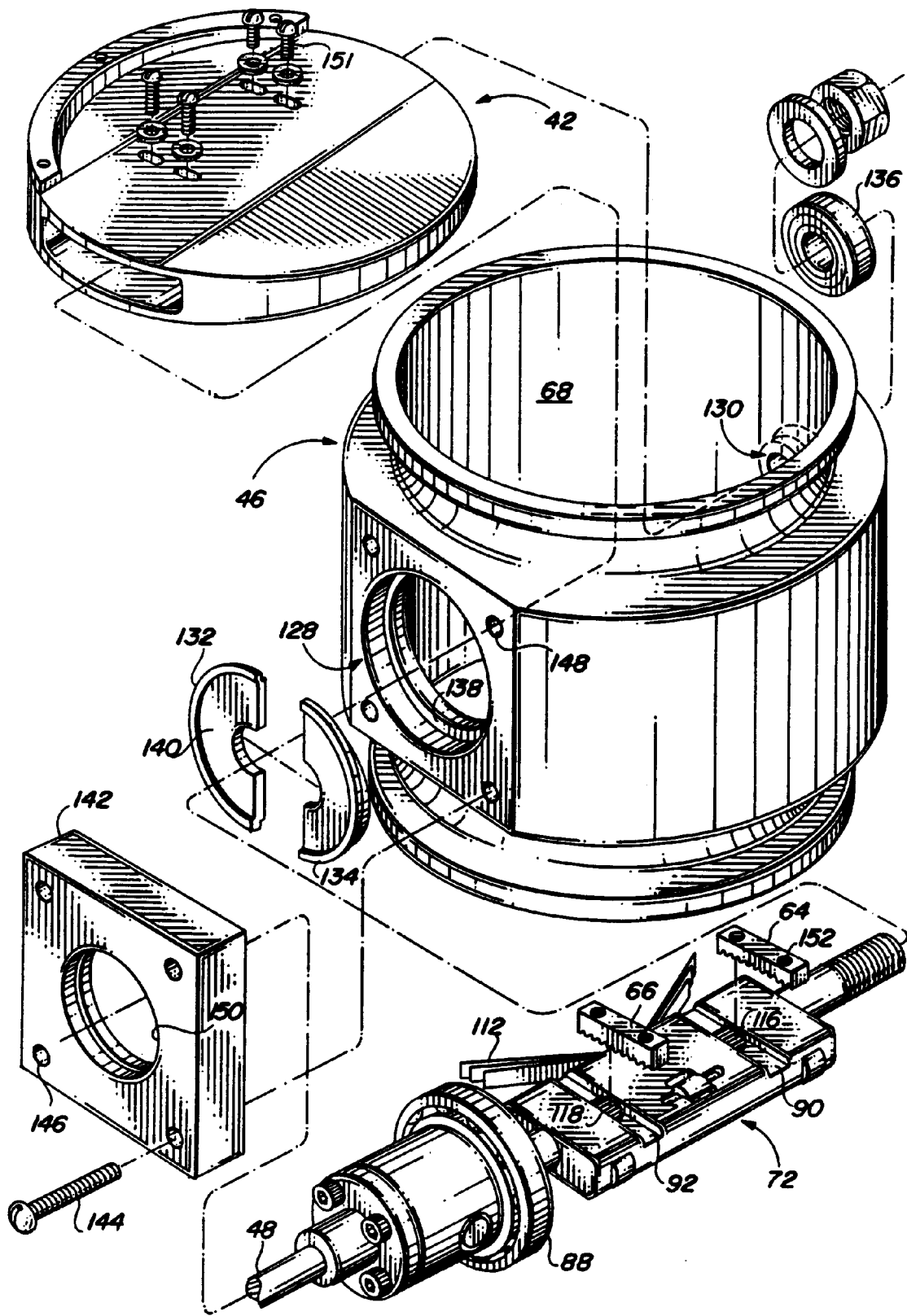
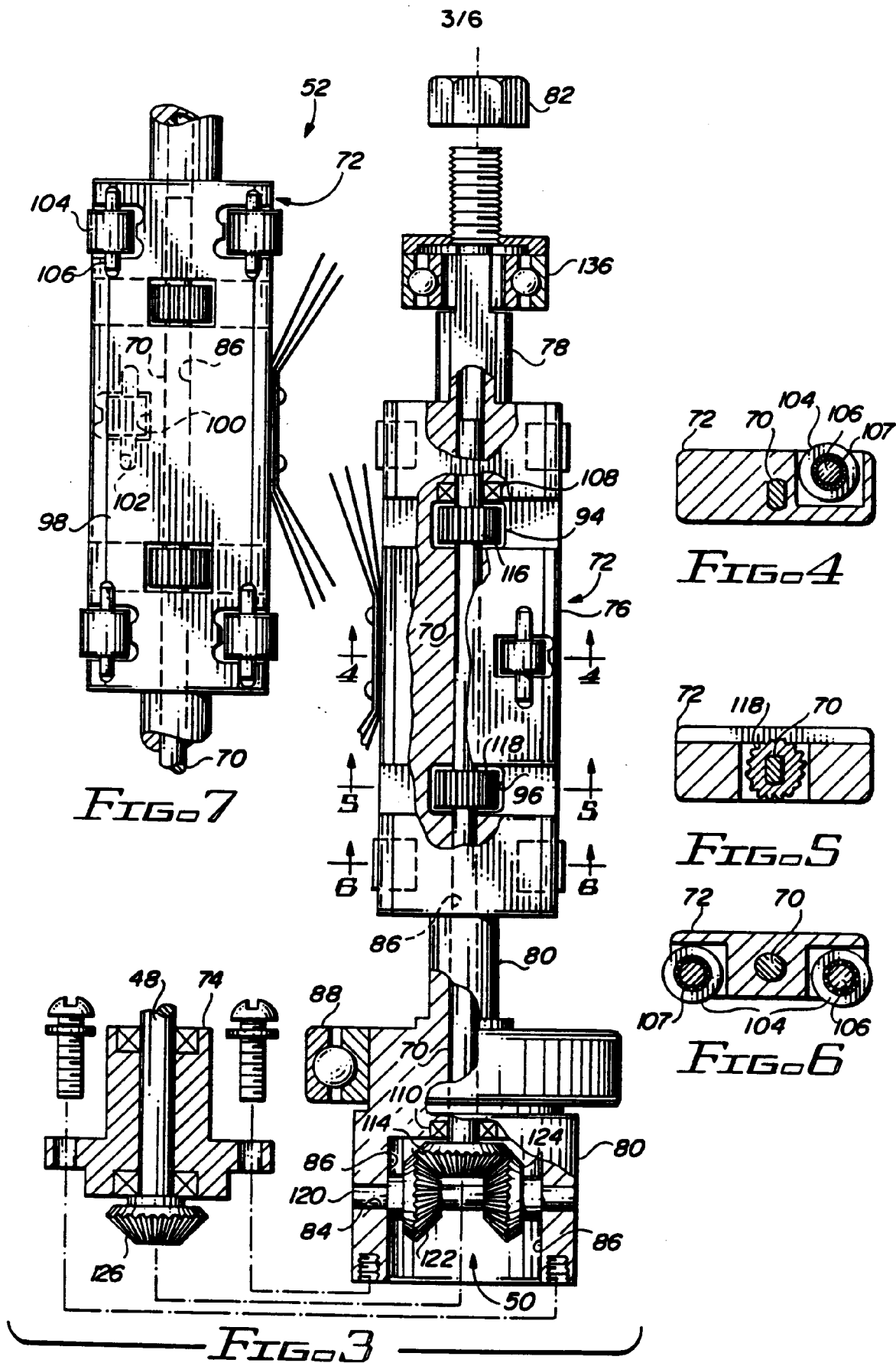
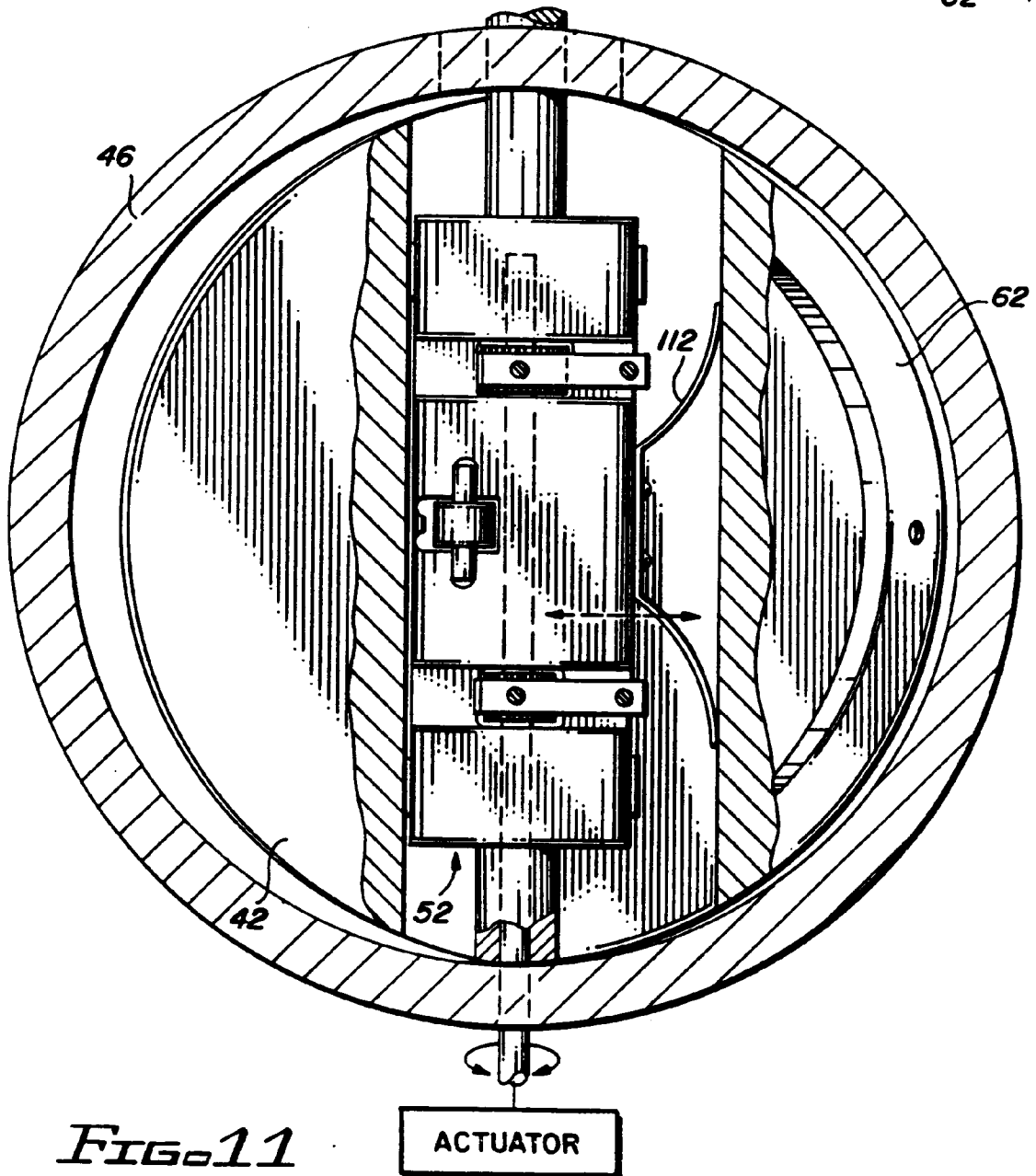
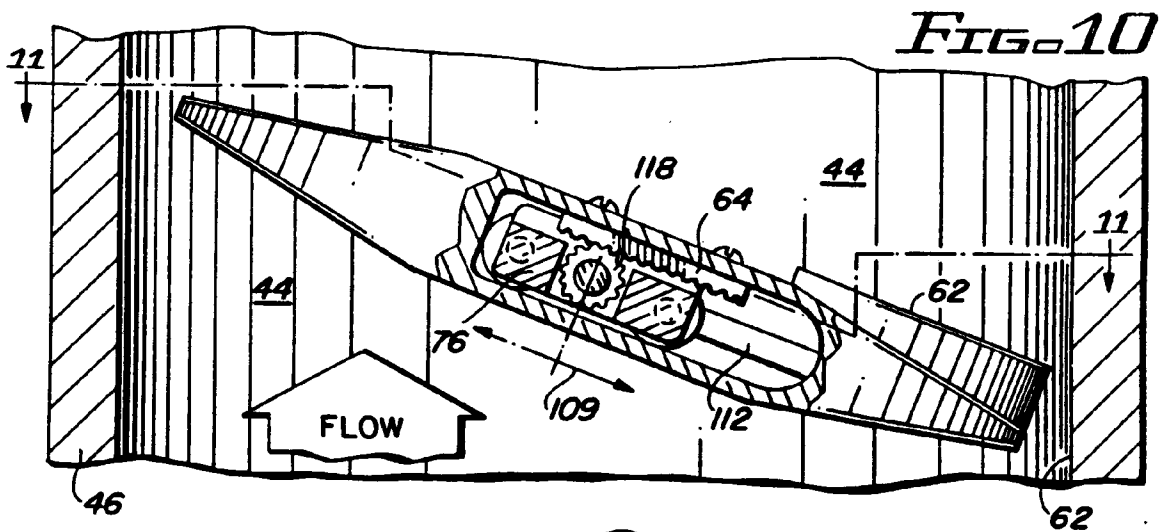


FIG. 2





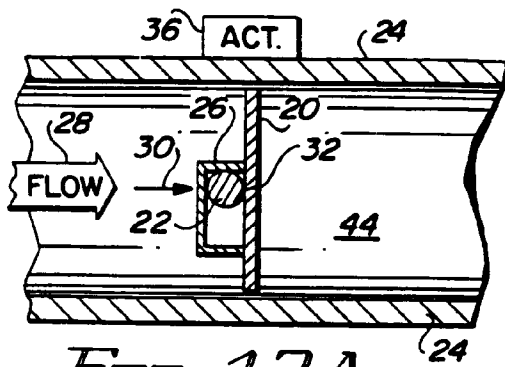


FIG. 12A

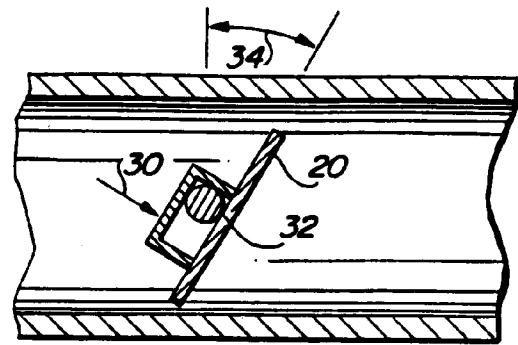


FIG. 12B

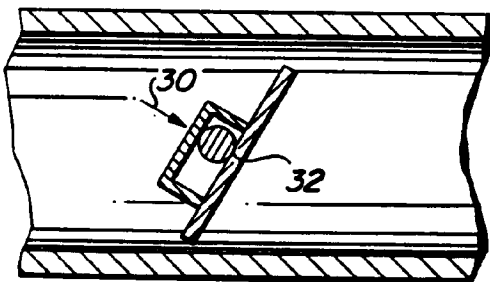


FIG. 12C

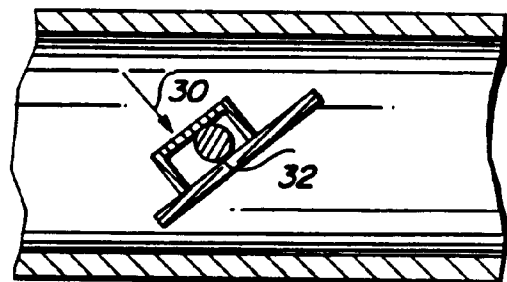


FIG. 12D

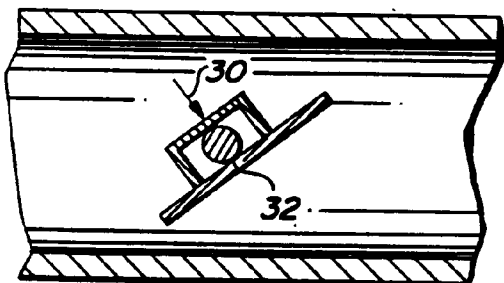


FIG. 12E

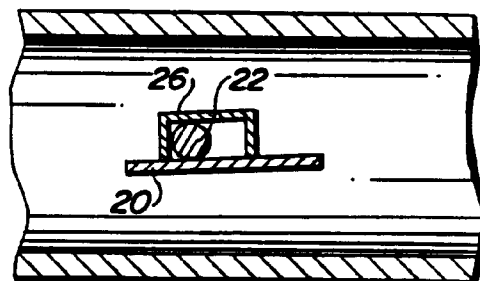


FIG. 12F

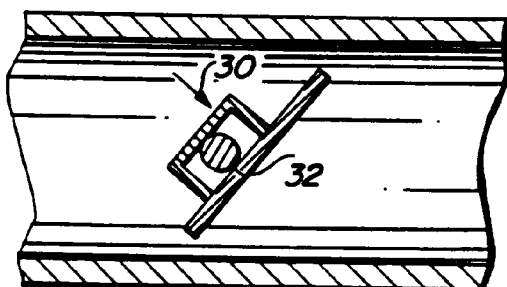


FIG. 12G

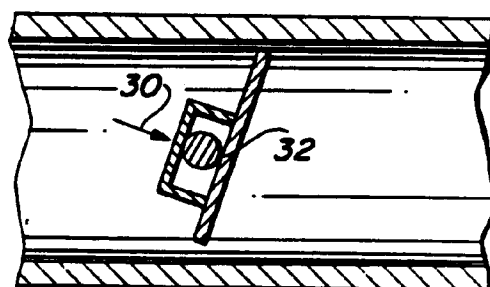


FIG. 12H

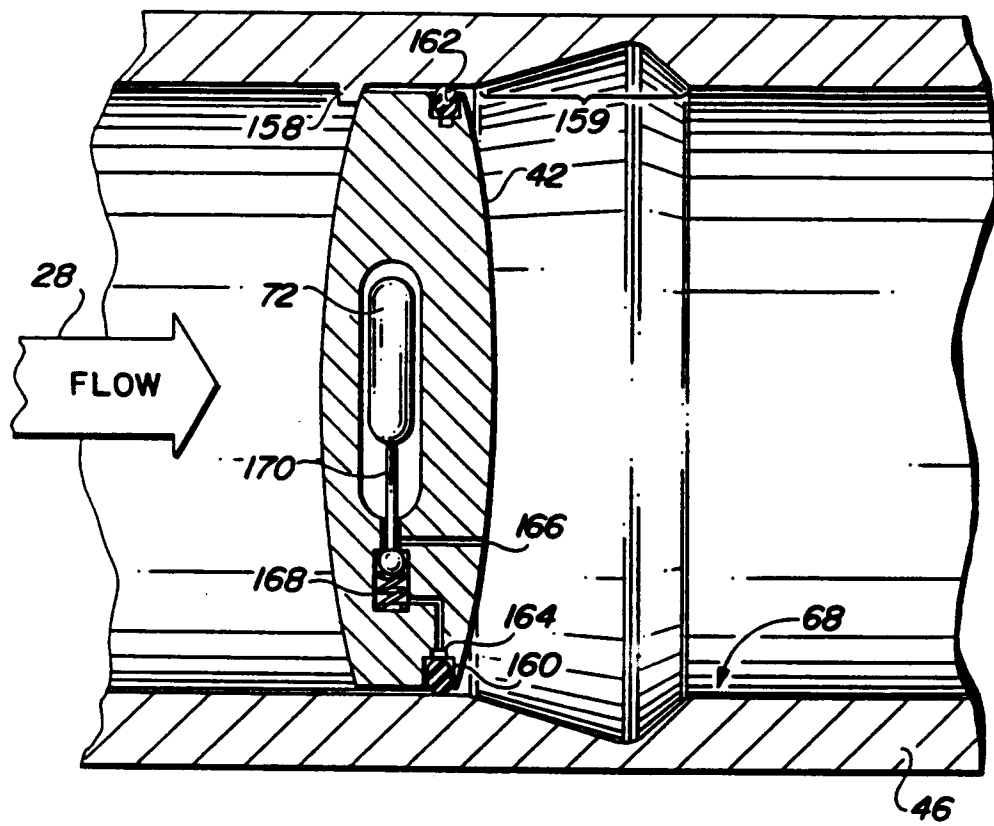


FIG. 13